Title of the project:
Mechanics of drilling in model biomaterials

Category (translational/bioengineering/biodesign) : Bioengineering

Investigators: Tejas Murthy, IISc

Statement of Research:
The proposed research will build on the research on drilling in metals and model porous brittle solids such as gypsum with two coordinated thrusts focused on model biomaterials. *Firstly*, a series of model tests will be carried out on laboratory reconstituted model materials using gypsum in the laboratory to generate a series of benchmark/ backbone mechanisms. Following this, an extensive characterization of the deformation in bone and teeth, as a function of controllable process variables will be carried out. Advanced experimental mechanics techniques such as high-speed imaging, and subsequent image analysis will be introduced. The evolution of deformation will be mapped through these experiments and a relation will be established between the geometry or boundary conditions (such as the apex angle of the drill, the helix angle of the drill) imposed and the consequent deformation. The commercially available drills will be used for mapping the deformation parameters such as strain rate, and strain will be used to isolate fractures, and shear planes and other regions of bifurcations. Comparison to metals and traditional brittle solids such as glass, will also enable development of appropriate theoretical framework. *Secondly*, micromechanics of the deformation such as fracture propagation, pore and structure collapse, and wear in the tooling will be used to optimize the tool geometries (i.e. drill geometries). This will result in deformation-geometry-micromechanics maps for biomaterials. An attempt will also be made for understanding of this micromechanics by conducting some experiments inside a computed tomography set up. The changes in microstructure such as pore collapse, distribution of localization features such as fractures will be mapped in three dimensions. Digital volume correlation will be used for mapping deformation parameters in the body of the solid. The presence of porosities will also quantified through using a watershed algorithm. These measurements will provide an appropriate mechanistic- basis for carrying out a series of parametric studies using continuum finite element simulations. The findings of this research programme will be used to initiate a further device development programme.